HVAC: Residential Duct Systems

Description

A number of modifications are being proposed in this area in order to ensure residential duct systems are both well designed and installed.
The proposed changes include:

Duct Location and Area. Improvements to the Residential Manual will encourage the use of ducts in conditioned space and reductions in duct surface area through shorter runs.

Unlined Flex Duct. Prohibit unlined flex ducts that use the outer vapor barrier as the only air barrier.

Duct Design. Duct designs will match the equipment and meet accepted design criteria for flow, static pressure, and noise. The special case of duct design for multiple orientations will be addressed.

Duct Leakage Test. Alternative duct leakage test methods, such as the Delta Q method, may be added.

Duct Insulation. Minimum duct R-values above 4.2 will be increased.

Duct Efficiency Calculations. The ACM Manual duct efficiency calculations will be reviewed and potentially revised to implement changes proposed in ASHRAE 152P and to simplifying requirements, where possible. This could include moving the Thermostatic Expansion Valve (TXV) credit out of the duct efficiency calculations.

Hourly Duct Efficiency Model. An hourly variable duct efficiency model will be added to represent the impact of duct losses on peak loads. This would support the Time Dependent Valuation (TDV) modeling approach.

Integrated Ventilation Systems. The effects of ventilation systems that are integrated with the HVAC system will be examined to determine how to assess their energy performance.

Benefits

Residential duct systems waste energy through excessive conduction losses in the winter and conduction gains in the summer. When they leak, they increase infiltration of outside air into the house, waste conditioned air, and cause pressure differentials that can result in the failure of combustion venting systems to operate as designed. When they are well designed and installed, the systems provide lower energy consumption and greater comfort. The savings from efficient ducts are largest at peak electrical consumption periods in summer and winter.
TDV would further reveal the outstanding peak reduction benefits of these measures.

Environmental Impact

The environmental impacts from these potential changes would be mostly positive. Indoor air quality is improved if leakage-induced pressure differentials are reduced to pull less contaminants from attics, garages, and crawlspaces into return ducts. Environmental emissions are lower because of the reduced annual energy consumption and, more importantly, because of the reduced consumption on peak when higher emitting power plants are on line. A potential increased consumption of insulation materials may occur if there is a higher duct insulation requirement, but a potential reduction in the consumption of duct material will result if there are shorter ducts or if ducts are inside conditioned space.

Type of Change

These changes could be addressed as noted below. The best method of implementing these changes will be discussed.

Duct Location and Area. The Residential Manual would promote a more widespread use of ducts in conditioned space as well as shorter duct runs by providing more thorough explanation of effective approaches and design considerations. This would not entail any new minimum compliance requirements.

Unlined Flex Duct. The elimination of unlined flex ducts that use the outer vapor barrier as the only air barrier would be implemented as a mandatory measure. All the Standards documents would have to be revised to reflect this new requirement.

Duct Design. The implementation of duct designs matched to the equipment and meeting accepted design criteria could be addressed as a prescriptive requirement, mandatory measure, or compliance option. If it were a mandatory measure, it would provide increased requirements on duct systems. It would replace the current ACCA Manual D credit with a simpler and better defined set of criteria. All the Standards documents would have to be revised.

Duct Leakage Test. Providing alternative duct leakage test methods would call for a new compliance option. There are a number of new tests being investigated, including the Delta Q method, which may provide more accurate estimates of the duct performance and may be more easily implemented under certain circumstances.

Duct Insulation. Increased duct R-values above 4.2 would be considered a revision to prescriptive requirements.

Duct Efficiency Calculations. Simplifying and changing duct efficiency calculations based on recent research would require revisions to the ACM Manual for duct efficiency. Consequences on the stringency of the Standards, if any, would need to be evaluated.

Hourly Duct Efficiency Model. This is an ACM Manual modeling change.

Integrated Ventilation Systems. Also an ACM Manual modeling change, this proposal would require the energy use related to ventilation systems to be included in compliance calculations.

Measure Availability and Cost

Duct Location And Area. Currently, only the most sophisticated builders address duct locations, terminal locations, and duct length. Most provide only minimal direction to the installing contractor. With the proposed change, there would be increased design time to bring the ducts into conditioned space or to specify alternative terminal locations (high inside wall or central in the ceiling). The effect would be slightly higher design costs, with the potential for lower materials costs (shorter ducts), smaller compressors, and lower installation costs. The cost of revised home designs that allow proper areas for duct runs will be investigated, and information will be supplied in the manuals on the most cost effective approaches.

Unlined Flex Duct. Manufacturers produce a variety of flex ducts. Some of them have no inner air barrier, but depend on the integrity of the outside vapor barrier to contain the air, which has a high potential for failure. However, manufacturers have sufficient alternative products.

Duct Design. ACCA Manual D, SMACNA, ASHRAE, and others all have duct design criteria. However, these criteria are routinely ignored in practice. The cost of a system designed to adequate criteria varies. The costs depend on the size of the heating and cooling source, the selection of the air handler, and the expertise of the designer. A well-designed system by an expert designer should be no more costly than a standard design, particularly if the design is used on multiple buildings.

Duct Leakage Test. The current duct leakage tests require specialized equipment, which is now widely available in California. The additional test procedures under consideration would allow the use of different specialized equipment. Manufacturers exist for all the equipment that would be allowed and they can provide sufficient quantities for use. The potential alternative tests may be less expensive under some circumstances.

Duct Insulation. Higher R-value ducts are available from multiple manufacturers. The higher R-value ducts are more expensive, but may be justified by life-cycle cost analysis. Higher R-values are currently required by the *International Energy Conservation Code* and have been adopted by other western states.

Duct Efficiency Calculations. Duct efficiency calculations are already implemented in the standard. These calculations and verification might be simplified. If so, the costs would be reduced.

Hourly Duct Efficiency Model. This computer modeling change will be invisible to the user.

Integrated Ventilation Systems. This is an ACM Manual modeling change.

Useful Life, Persistence and Maintenance

These measures have lifetimes approaching the life of the home, with no maintenance or persistence issues.

Performance Verification

The current *Standard* requires verification for: Duct Leakage Reduction, Duct Design, Duct Surface Reduction, and Duct Location better than the Default Location. The changes proposed should have verification requirements sufficient to ensure high performance for the substantial majority of the installations, without causing undue economic burden or time delays to building completion.

Cost Effectiveness

Any changes to the mandatory measures and prescriptive requirements will be shown to be cost effective relative to the current standard. Compliance options are very likely to be cost effective compared to current standard.

Analysis Tools

The primary analysis tools for these changes will be duct efficiency simulation models. These models include ASHRAE 152P, the FSEC Duct Model, and the Proctor Engineering Group Duct/AC Model. Secondary tools are ACCA Manual D and ASHRAE calculations contained in the *ASHRAE Handbooks*.

Relationship to Other Measures

The efficiency of the duct system is quite dependent on the sizing and airflow of heating and cooling equipment.

Bibliography and Other Research

Researchers and contractors active in duct issues will be consulted and recent publications will be reviewed. The following is of particular interest:

ASHRAE 152P - Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems.